6. Bibliographic Data Entry

A number of our users have developed programs for automation of preprint and bibliographic files. These will be reviewed and a suitable program adapted for public use.

7. Time-Oriented Medical Records Support and Other Patient Data Base Studies

By the fall of 1972, we hope to review all the work performed to date on time-oriented medical records in order to select the optimal file design, the data entry format, and retrievable vocabulary for the near term users. Our goal will be to provide the system tools and the systems or applications programming that will yield generalized programs which can be used by many different departments in the Medical Center. We have found that implementing the system in the Oncology Department required some changes from the programs used for the Immunology Clinic. We have been impressed by physician acceptance of the time-oriented medical record. Please refer to the user project descriptions for Drs. Fries and William for additional explanation of the time-oriented medical record concept.

Additional patient data base studies will be undertaken with the following goals:

a. Obtain as much information as possible concerning new file systems to be supported by IBM and other manufacturers. Review the Stanford SPIRES system as to its applicability.

b. Monitor carefully the problems encountered at Stanford in use of the time-oriented medical records.

c. Through literature, search, and travel remain well informed of work being performed elsewhere.

d. Assign at least one Computer Science department graduate student (research assistant) to the problem of file structure design for patient medical records.

The goal of these studies will be to provide a broad base of information on file system technology and patient data base systems that will be used to guide Stanford's development and implementation of medical information systems.

C. Hardware Acquisitions

Rental and purchase funds are included in the FY73 budget for several additional items of hardware. A discussion of each item follows.

1. Terminals

Several 2741 terminals will be released and funds will be used to acquire two additional high speed hard copy terminals and four CRT terminals. We are especially interested in terminals capable of operating at 1200 baud. The choice will be limited to standard EBCD, Correspondence Code, and ASA terminals, if at all possible.

2. Public Printer/Plotter

The availability of a relatively fast printer/plotter device for general use has been requested by our users. We have been looking at several electrostatic printers, as such a device provides extremely fast and flexible printing and plotting. However, electrostatic devices place a high demand on CPU and channel resources. A further review of available plotters will be conducted before a decision is reached.

3. PDP-11 Equipment

An item is included for purchase of additional core memory for both the development PDP-11 and the front-end PDP-11.

Several additional devices (printer/plotter, DEC tape, voice drum) are to be attached to the front-end PDP-11. Available core will not be adequate to service these devices.

The current 8k of core on the development PDP-11 is minimal for DEC's operating system. Furthermore, several users have been unable to perform some operations due to the core limitation. An additional 8k is required.

4. Ampex Disk Drive

Current 360 disk utilization approaches full capacity. Addition of a new user pack may be necessary unless significant savings result from the new file compaction algorithm.

The disk configuration is eight on one control unit, eight plus spare on the other. On the first control unit, the eighth drive serves as a spare since only fifteen disk packs must be permanently mounted. If we decide to add an additional user pack (always permanently mounted), rental of a second spare drive guarantees better system reliability.

5. Miscellaneous

This category includes interfaces and cabling for the voice drum and additional acoustic couplers and modems (particularly for 1200 baud terminals).

D. System Software

The specific suggestions for system software tasks are derived from four criteria:

1. The software should be stabilized as soon as possible.
2. System documentation must be completed.
3. Additional or improved user services should be aimed toward attracting additional income.
4. All changes in the form of additional features should be disallowed and the system frozen by the end of the grant year.

Three major modifications (points 5, 6, and 7) are in direct conflict with rquirements one and four. However, they are also the primary tasks for achieving requirement three.

1. System Stabilization and Cleanup

The effort here will concentrate on the elimination of known inconsistencies and errors in the system. Wherever easily possible, attempts will be made to reduce the size of the software.

2. Documentation

A considerable documentation effort is planned. The aims are to remove incompleteness and redundancies in the current documentation of the system software. A general paper should be written explaining the system design, the general functional flow, and the interactions of the various components. Also, a comprehensive table of contents and a cross index to each subject category is useful.

Cleanup of documentation and the software will benefit any transfer of the system code to another machine and it will expedit the maintenance of the system by a reduced staff.

3. Support of Additional Hardware

We anticipate attaching a number of new peripheral devices to the system. A list of possibilities is discussed in Section C above.

Additional software will be required in the front-end PDP-11 system for support of the voice drum, DEC tape (purchased from this year's grant), and a printer/plotter. Depending upon the type of printer/plotter selected, we may be able to adapt manufacturer-supplied software.

With the installation of the Memorex 1270 controller, session-controlling devices (terminals) and graphics devices are often synonymous. A few of the planned projects are:

a. Where necessary, add specialized terminal support. An example is the inclusion of the Correspondence Code translation table as developed by the Stanford 360/67 facility for the unique features of the IBM Magnetic Card Selectric Typewriter terminal (MCST). The new TEKTRONIX terminals (4010), if selected, will require some specialized support.

b. Add a few terminal control commands, such as SET UPPER/UPLOW and SHOW CASE for specifying upper and lower case options. Other commands determine the terminal type (ASA or TTY), and suppress or allow transmission of the ACME light box characters.

c. For high-speed displays, incorporate modifications to the LIST command so that output is suspended every N lines. This allows the user to scan a page of lines and use BREAK if he is interested in stopping at that point.

d. Implement page mode output for displays. A full screen of data is displayed directly from the user's in-core array or variables with a single command. The user may then modify the contents of the screen and read it back with another command. Some of the problems in implementation of this capability are identical to those discussed under 'Extended Logon'.

4. Additional Satellite Machine Support

Satellite machine support will focus on tasks essential for a smooth transition to SUMEX and other long range programs expected to succeed ACME. In addition, assistance will be provided to small machine users wishing to connect to the new small machine multiplexor.

5. Batch and OS Services

The provision for a user batch service seems necessary for several reasons:

Current methods for submission of user disk-to-tape jobs and for submission of LISP overnight work are inadequate and operationally difficult to control.

Our present method for providing routine printing and punching services invites some danger to the reliability of the ACME system. Occasional long delays produce poor turn-around time.

A number of jobs now routinely executed from an ACME terminal need not be run interactively. Scheduling these jobs for overnight batch frees both the terminal and the CPU for additional on-line work.

Recent hardware monitor tests indicate that the CPU is busy for 90%-95% of available cycles during peak daytime hours. Also, there is little free core available during the same hours.

Consequently, only a small printing/punching utility region could be supported during the prime shift. However, sufficient core and cycles are available during evening and overnight shifts to accommodate a limited load of user batch work.

Provision for a batch service requires the completion of these tasks:

a. An OS-type task which will convert ACME-type files to OS files and the converse. The design document on this feature has been completed. Both direct access and tape data sets will be supported.

b. Incorporation of the HASP system into the OS supervisor. HASP facilities are preferred over conventional OS services for both better operational control and for its smaller core and disk requirement.

c. Review of the WYLBUR/HASP interface and its adaptation to the ACME system, if possible. Otherwise, the development of a capability to communicate with the HASP in-core reader.

d. Development of a small library of standard OS procedures for routine utility operations (printing, punching, etc.)

e. Adaptation of HASP accounting. Development of a program to merge HASP accounting with time-sharing accounting.

6. PL/ACME Object Modules

The ability to save compiled code on a PL/ACME program and reload it at a later time has been repeatedly requested. Unfortunately, we have avoided the subject primarily because of the lack of a definitive statement as to its impact on the current design of compiled code.

Reloading of compiled code saves user setup time. It also frees CPU cycles now used for recompilation for more productive purposes.

Due to the time constraints of the next year and due to the uncertainties mentioned above, this project is initially planned as a two man-month study and design specification. Actual implementation plans will be deferred until the level of effort is known and until the choice of a computer system is determined.

7. Extended Logon

As the ACME system is currently configured, a user session can be controlled only by a device routed through the Memorex 1270. References to the desirability of expansion to logon services are to be found throughout this report.

Specifically, some of the extensions are:

a. Allow a satellite computer to function as a terminal, invoking programs, etc.

b. Allow our front-end PDP-11 to act as a master terminal, 'logging on' users from devices not necessarily capable of sending and receiving lengthy transactions (such as touch-tone telephones).

c. Provide a master/slave terminal concept, so that one copy of a user program can service multiple requests from multiple, geographically separate, users.

d. Page mode support for CRT's requires extension to the 'one-line-at-a-time' mode of operation.

The precise technique for implementation has not been determined. However, a reorganization of high-level system control functions is absolutely necessary. Expansions to the GET/PUT and READ/WRITE statements of PL/ACME are a possibly simple scheme for user communications.

We feel that this is the most valuable of all suggestions for additions to the ACME system. The considerable design effort and its impact upon the total structure of the system software are more than justifiable.

8. Miscellaneous

This category contains a number of small projects, none of which may produce any significant increase in system usage, but all of which provide gratifying additions to the current level of service. Compared to the level of effort anticipated for implementation of other proposals in this section, these projects require very minor manpower expenditures.

a. A method whereby a user may determine his aggregate monthly charges from his terminal (SHOW CHARGES command).

b. Extensions to the Text Editor to allow relocation or duplication of lines of text within a data set (MOVE/COPY commands).

c. Addition of the UNPROTECT command to complement the PROTECT command. This command is necessary if a user wishes to delete or maintain an existing protected file.

d. A technique is needed whereby a user can guarantee sufficient disk file space for writing data to his data set. A simple implementation is to provide an option wherein the user specifies the number of disk blocks required at OPEN time. The blocks are held in reserve for him (assuming they are available) until either they are consumed or the file is closed.

V. ADMINISTRATIVE ORGANIZATION

Stanford University has an Associate Provost for Computing and reports directly to the Provost and Academic Vice President. The Provost for Computing and heads the operation of three major facilities: Campus facility, ACME facility, and SLAC computing facility. The current SCC director, Charles Dickens, has made a number of organizational and procedural changes during the past year in an effort to find an optimal organization for Stanford's system programming efforts. One finding was that organizational rather than functional lines seem to be the most appropriate in the Stanford setting. For six months we had a single systems group manager for all three facilities - SLAC, Campus, and ACME. Some benefits of the trial period were the creation of a better reporting system, cross-fertilization of ideas, and much more interaction among the systems programmers. Some of the disadvantages were a longer communications chain, travel time between facilities, and some loss of control by facility directors. The operations managers of the three facilities were also brought together in one functional arm of the organization. Cross-facility training among operations was partially completed. Reporting schemes were unified, and an exchange of ideas was accomplished. Today, the functional organizations exist for purposes of communication and coordination. Formal lines of authority, however, have been returned to individual facility directors.

We have had a number of meetings in the past year with the Hospital Data Processing facility director and his staff. A new era of cooperation and communication between Hospital Data Processing and ACME has arrived.

The personnel currently on the ACME payroll, their job function, and percent of full time equivalents are listed below:

CURRENT ACME PERSONNEL

NAME	%FTE	JOB TITLE
Jamtgaard, R	100	Director
Wiederhold, G	20	Consultant
Kindfleisch, T.	50	Systems Analyst
Hundley, L.	100	Systems Programmer
Frey, R.	100	Systems Programmer
Granieri, C.	100	Systems Programmer
Lew, Y.	100	Systems Programmer
Miller, S.	100	Systems Programmer
Briggs, R.	20	Systems Programmer
Stainton, R.	100	Systems Programmer
Bassett, R.	100	Scientific Programmer
Crouse, L.	100	Scientific Programmer
Whitner, J.	100	Scientific Programmer
Aranda, M.	100	Secretary
Baxter, E.	100	Administrative Asst.
Class, C.	100	Operations Manager
Cower, R.	100	Computer Operator
Sutter, J.	80	Computer Operator
Matous, J.	100	Computer Operator
Mieman, J.	60	Computer Operator
Cannon, D.	50	Dispatcher
Total FTE	17.9	

VI. BUDGET

A. Resource Expenditures

SUMMARY

		Total Resource Expenditures		
		Actual Previous Budget Period	Current Budget Period	Estimated Next Budget Period
1.	Personnel:			
	a. Salaries & Wages	239,329	248,690	277,162
	b. Staff Benefits	32,851	37,505	44,231
	Subtotal	272,180	286,195	321,393
2.	Consultant Services	912	1,000	1,000
3.	Equipment			
	a. Main Resource-Rented	384,542	389,458	390,596
	b. Main Resource-Purchased	40,848	54,479	50,000
	c. Supporting Equipment	1,951	1,260	1,260
	d. Equipment Maintenance	6,145	14,500	18,805
	Subtotal	433,486	459,697	460,661
4.	Supplies	15,873	9,200	9,700
5.	Travel	3,047	4,000	4,000
6.	Engineering Services	11,818	30,000	31,500
7.	Publication Costs	3,031	2,000	2,500
8.	Other			
	a. Computer Services (1)	8,272	3,100	7,900
	b. Other	9,531	10,100	11,200
	Subtotal	17,803	13,200	19,100
9.	Subtotal - Direct Costs	758,150	805,292	849,854
10.	Indirect Costs	141,205	76,600	21,771
11.	Total Costs	899,355	881,892	871,625 (2)

(1) Includes education courses

(2) Assumes $443,976 exempt equipment costs and user income of $360,000.

B. Justification for FY1973 Budget

Fiscal year 1973 will be the final year for the ACME Grant. The gross operating costs will be slightly higher than fiscal year 1972, primarily due to salary increases, some incremental equipment rent and maintenance, and some additional programming help for users. The emphasis in this final year will be one of pulling loose ends together and preparing for a transition to alternate hardware for research and service computing. In addition, strong effort will be made to improve the income posture of the facility so that it can survive in future years without the financial guarantees provided under the ACME Grant.

The budget for fiscal year 1973 assumes that the staff level achieved in fiscal year 1972 will be retained. The facility is currently recruiting a replacement for Gio Wiederhold who has had primary responsibility for liaison with users and supervision of the consultants. Gio Wiederhold assumed new responsibilities in the Hospital Data Processing Facility in March, 1972. ACME continues to pay a fraction of his salary for consulting on system problems and planning.

An average salary increase of 5% has been included in the budget for fiscal year 1973.

Equipment rental costs have been budgeted at the current rental rates. The overall equipment rental budget is slightly higher than fiscal year 1972 due to the installation of Ampex core. Similarly, the hardware maintenance budget is up slightly due to acquisition of terminals and aging of interface hardware built during the past six years, and maintenance of the small machine equipment pool acquired over the past 18 months.

Some miscellaneous budget elements include funds for training of staff on the PDP-10, acquisition of some terminal service on PDP-10's run by other institutions, and some additional communications costs associated with the move to multiple speed terminal support made in April, 1972.

Capital equipment requested for the new budget period is as follows:

1)	Four CRT terminals	12,600
2)	Electrostatic Printer/Plotter, or expansion of small machine equipment pool	22,000
3)	8K of core for development PDP-11	5,700
4)	4K of core for production PDP-11	3,300
5)	Two 30 character per second typewriter terminals	5,000
6)	Acoustic couplers, modems, etc.	1,400
	TOTAL	$50,000

The CRT's and 30 character per second typewriter terminal will replace IBM 2741 terminals which have been rented by the facility in the past. The terminals are less expensive and will provide faster output and a savings of programmer time. The printer/plotter to be acquired has not been selected yet. This item is incorporated in the budget because graphic support continues to attract more users. At the present time the ACME facility has no plotter to support its users. Three user groups have plotters attached to ACME and they find the provision of service to miscellaneous users more than a trivial nuisance. Provision of good interactive graphics support on the ACME system will demand that the facility offer plotting to its users. Another problem which we have had is the slow turnaround on print jobs caused by the speed of our printer and the system degradation caused by use of the printer while PL/ACME is running. This latter problem is induced by IBM hardware and software constraints which cannot be fixed without a very sizable expenditure of effort.

The core for the Development PDP-11 and Production PDP-11 systems will permit use of the DEC Fortran compiler on the development system and will remove the limitation which has hampered the efforts of several development groups. The added core for the production PDP-11 will be needed only if several additional user devices or services are interfaced through the PDP-11. We have barely enough core to mount the voice drum at the present time. We assume that additional special devices will be needed.

Funds for acoustic couplers modems, etc., will be needed to effectively use the new terminals from remote locations. Also, a number of medical school groups are being moved to space adjacent to but outside of the current Medical Center buildings. For such users, telephone service for terminals is a must. This requires expansion of the communication equipment available. Users pay for their own terminals and acoustic couplers but the facility helps to respond to their temporary requirements or new requirements pending delivery of new equipment.

C. Expenditure Details

DIRECT COSTS ONLY

	August 1, 1971-July 31, 1972	August 1, 1972-July 31, 1973
1. Personnel		
Director's Office	32,929	23,582
Systems Analysis	4,633	10,600
Systems Programmers	94,306	97,960
Applications Programmers	39,042	63,470
Research Assistants	9,852	7,150
Operations	52,430	58,680
Secretarial & Administrative	15,498	15,720
Subtotal, Salaries	248,690	277,162
Staff Benefits	37,505	44,231
TOTAL PERSONNEL	286,195	321,393
2. Consultant Services	1,000	1,000

C. Expenditure Details

DIRECT COSTS ONLY

			August 1, 1971-July 31, 1972		August 1, 1972-July 31, 1973
3. Equipment					
Major Equipment					
1052	Console Typewriter		635		635
1403	Printer 600 LPM		8,397		8,397
2050	Additional CPU (F)		99,955		101,817
2314 #1	Dir. Acess Storage		21,466		-----
2314 #2	Dir. Acess Storage		19,988		-----
2361	Core Storage		27,291		-----
2401	Mag. Tape Unit		3,377		3,377
2403	Mag. Tape Unit Control		8,971		8,971
2540	Card Reader Punch		6,947		7,157
2701	Data Adapter Unit		10,561		10,728
2702	Transmission Control		16,834		-----
2821	Control Unit		10,937		10,937
	Ampex DC 314		20,068		36,304
	Ampex DC 314		22,243		36,304
	Ampex ECM-50		77,949		119,922
	Memorex 1270		-----		16,248
Subtotal			355,619		360,842
Disk Packs (IBM 2316/3)		(25)	2,114	(25)	2,100
Terminals (2741)		(11)	11,763	(4)	4,109
IBM 1800 add. units					
1442			2,638		2,671
1826			7,691		7,691
1856			1,701		1,701
Subtotal, 1800			12,030		12,063
Unit Record 029			1,192		1,259
TOTAL, RENTALS			382,718		380,373

C. Expenditure Details

DIRECT COSTS ONLY

	August 1, 1971-July 31, 1972	August 1, 1972-July 31, 1973
Purchased Equipment		
RPQ's for Beehive Terminals	381	
PDP-11 System	38,466	
DEC Dual Tape System	8,700	
1200 Baud Modems (2+ Power Supply)	750	
Computer Terminals (2)	6,182	
Four CRT Terminals		12,600
Electrostatic Printer/Plotter, or expansion of small machine equipment pool		22,000
8K of core for development PDP-11		5,700
4K of core for production PDP-11		3,300
Two 30 character per second typewriter terminals		5,000
Acoustic couplers, modems, etc.		1,400
	54,479	50,000
Data Set and Line Rentals	8,000	8,400
Maintenance (Under outside contract)	14,500	14,805
Total Equipment	405,218	403,578

C. Expenditure Details

DIRECT COSTS ONLY

		August 1, 1971-July 31, 1972	August 1, 1972-July 31, 1973
4.	Consumable Supplies		
	Office	3,700	3,700
	Computer	5,500	6,000
	Subtotal, Consumable Supplies	9,200	9,700
5.	Travel		
	Frey -U. of Missouri Comp. Ctr., 8/6/71		
	-SHARE, New York, 8/9-12		
	-Automated Health Sys., Wakefield, Mass., 8/13	777	
	Nozaki -WESCON, S.F., 8/25	9	
	Wiederhold-SIGPLAN Symp., Purdue Univ., 10/24-26	359	
	Jamtgaard -MUMPS Sys., Boston Gen. Hosp., 11/28-30	426	
	Jamtgaard -Conference, S.F., 1/19-1/21/72	78	
	Wiederhold-Conference, S.F., 1/19-21	78	
	Wiederhold-Conference, Washington, D.C., 1/28-29	364	
	Granieri -SHARE, S.F., 3/6-10	20	
	Wiederhold-SHARE, S.F., 3/6-10	74	
	Granieri -IBM Class, S.F., 4/12-14	33	
	Class -SJCC, Atlantic City & DEC, Boston 5/15-18	525	
	All Other Travel	1,257	
	Subtotal, Travel	4,000	4,000
6.	Engineering Services	30,000	31,500
7.	Publication Costs	2,000	2,500
8.	Computer Services		
	360/67	2,500	2,500
	PDP-10 and Line Charges	----	3,000
	Staff Training	600	2,400
	Subtotal, Computer Services	3,100	7,900

C. Expenditure Details

DIRECT COSTS ONLY

	August 1, 1971-July 31, 1972	August 1, 1972-July 31, 1973
9. Other Expenditures		
Audio-Visual Presentation	----	700
Books and Periodicals	200	200
Postage and Freight	2,000	2,000
Telephone	7,000	7,000
Physical Plant	100	300
Technical Services	800	1,000
Subtotal, Other	10,100	11,200
GRAND TOTAL -- DIRECT COSTS	805,292	849,854

D. Summary of Resource Funding

	BUDGET PERIODS		
	Actual Previous Budget Period	Current Budget Period	Estimated Next Budget Period
Source of Funds			
Computer Equipment - Service	170,596	270,000	360,000
Biotech. Resources Branch Support			
Amount of Current Award:			
Line (5) of Award Statement	675,747	573,755	511,625
Adjustment from Prior Periods:			
1. Line (4) of Current Award	76,459	27,275	
	<27,275>		
2. Balance of 270 x/y Proceeds		5,292	
Total BR Support	724,931	606,322	511,625
TOTAL FUNDING	895,527	876,322	871,625

E. Resource Equipment List

RENTAL EQUIPMENT

360/50 Configuration

TYPE-SERIAL	DESCRIPTION	RENTAL START DATE	MONTHLY RATE	E/A%	EDUCATIONAL ALLOWANCE	TAX	NET RENTAL
IBM:							
1052-50618	Console Typewriter	12-13-66	63.00	20	12.60	2.52	52.92
1403-14708	Printer 600 LPM	"	833.00	20	166.60	33.32	699.72
2050-11047	Additional CPU (F)	"	2,073.00	25	518.25	77.74	1,632.49
2050-11047	CPU	"	10,040.00	35	3,514.00	326.30	6,852.30
2401-10877	Mag. Tape Unit	"	335.00	20	67.00	13.40	281.40
2403-70738	Mag. Tape Unit Control	"	890.00	20	178.00	35.60	747.60
2540-12531	Card Reader Punch	"	710.00	20	142.00	28.40	596.40
2701-11144	Data Adapter Unit	"	1,025.00	20	205.00	41.00	861.00
2701-11144	Data Adapter Unit		35.00	10	3.50	1.58	33.08
2702-20185	Transmission Control	"	1,670.00	20	334.00	66.80	1,402.80
2821-12464	Control Unit	"	1,085.00	20	217.00	43.40	911.40
AMPEX:							
DC 314-034	Dir. Acess. Stge.	12-20-71	2,907.00	--	------	118.35	3,025.35
DC 314-037	Dir. Acess. Stge.	1-13-72	2,907.00	--	------	118.35	3,025.35
ECM 50-1222	Core Storage	12 -8-71	9,545.00	--	------	448.50	9,993.50
360/50 Configuration Total			34,118.00		5,357.95	1,355.26	30,115.31

E. Resource Equipment List

RENTAL EQUIPMENT (Cont.)

Supporting Equipment Rentals

TYPE-SERIAL	DESCRIPTION	RENTAL START DATE	MONTHLY RATE		E/A%	EDUCATIONAL ALLOWANCE	TAX	NET RENTAL
25 units 911	Disk Pack (3M)	5-17-71	(@ 7.88)	197.00	--	------	9.85	206.85
6 units 2741	Communication Terminal	various	(@100.50)	603.00	20	120.60	24.12	506.52
5 units 2741	Communication Terminal	various	(@105.50)	527.50	20	105.50	21.10	443.10
1800 Rental Equipment								
1826-10152	Data Adapter Unit	9-22-66		763.00	20	152.60	30.52	640.92
1442-70295	Card Read Punch	"		265.00	20	53.00	10.60	222.60
1856-10607	Analog Output Terminal	6-24-70		150.00	10	15.00	6.75	141.75
Other Rented Equipment								
Card Punch	IBM (Model 029/P4202)	9-21-70		111.00	10	11.10	5.00	104.90

E. Resource Equipment List

PURCHASED EQUIPMENT

Period Covered -- 8/1/67-4/30/72

DESCRIPTION/IDENTIFICATION	MANUFACTURER	MODEL NO.	PURCHASE PRICE	SOURCE OF FUNDS
1800 System				Genetics I.R.L.
Process Controller	IBM	1801		
Printer Keyboard	"	1816		
Enclosure	"	1828		
Analog Input Terminal	"	1851	2,908.00	
Digital Display	ACME		(1)	SRR
Oscilloscope	Hewlett-Packard		1,500.00	Macy Grant
Pulse Generator	E.H. Research Labs	139B	1,275.00	Macy Grant
Conversion 1801	IBM	2B	18,753.00	
PDP-11 System	Digital Equipment	PDP-11	17,891.00	
Oscilloscope	Tektronix	547	3,253.00	
Printer	Litton Industries	30	4,053.00	
Module/Packs	Prentice	800/LDA-1	2,972.00	
Oscillator/Generator	Wavetek	130	309.00	
Couplers (2)	Prentice	D22	939.00	
Module	Prentice	LDA 1	383.00	
Cabinet	Prentice		4,182.00	
Disk Drive System	Digital Equipment	RK11 CA/RK03AA	15,332.00	
Beehive Displays (3)	Beehive	Model 3	7,668.00	
Sampling Unit	Tektronix	Type 152	1,767.00	
PDP-11 System	Digital Equipment	PDP-11	38,446.00	

F. Income Projection:

A revised rate structure was implemented effective April 16, 1972. In general, rates for use of ACME were increased by 25% to 30%. Some users computing bills were doubled as a result of the new increase. Actual income for the month ending May 15, 1972 amounted to $31,500. Some users will reduce their utilization due to the higher rates. A conservative estimate of income for fiscal year 1973 is $360,000. This figure does not include the terminal service fees which cover terminal rent plus other services to the ACME user community which could not be covered by the current funding level of the ACME grant. Some major users of the current system will be transferring loads to dedicated small computer systems in the next 12-month period. One such user is Dr. Stanley Cohen whose Drug Interaction Program should be running on a dedicated PDP-11 by early 1973. Another such user is Dr. Howard Sussman in the Clinical Laboratory; programs are being written now for use of the newly acquired Sigma 3 by the Clinical Laboratory. Both Drs. Cohen and Sussman will continue to make some use of ACME for data analysis but the income from these two sources will be much reduced over current levels. On the next page you will see a table which shows the monthly income collected by ACME for the past nine months. Based upon this experience and the estimated impact of the higher rates, it is felt that the $360,000 is a reasonable estimate of next fiscal year's income from computer service fees.

ACME INCOME

April 17, 1971 to April 16, 1972

360/50 Income From Chargeable Users	May	June	July	August	Sep	Oct	Nov	Dec	Jan	Feb	March	April	Total
1 - Realtime, sponsored research	$ 2,577	$ 2,372	$ 3,608	$ 4,500	$ 5,812	$ 5,550	$ 4,536	$ 5,346	$ 5,576	$ 6,203	$ 6,200	$ 6,578	$ 58,858
2 - Non-realtime, sponsored research	6,530	9,487	7,357	9,443	9,488	10,003	8,458	9,901	8,725	13,000	18,166	14,630	125,188
3 - Non-Stanford, medical	555	235	359	248	370	206	317	254	409	234	1,435	3,090	7,712
8 - Hospital Data Processing	2,286	2,634	1,260	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	11	6,192
9 - Stanford, non-medical	3,349	3,821	2,031	2,997	1,275	3,049	1,461	824	496	486	228	1,052	21,069
16 - Combination Core Research and Application	-0-	-0-	-0-	-0-	-0-	-0-	181	966	2,642	2,210	2,830	2,600	11,429
MONTHLY SUB-TOTALS	$15,297	$18,549	$14,615	$17,188	$16,945	$18,808	$14,953	$17,291	$17,848	$22,133	$28,860	$27,961	$230,448
Income from Terminal and Misc Charges*	$ 8,323	$ 8,625	$ 8,315	$ 9,053	$ 8,740	$10,393	$ 9,758	$10,845	$10,145	$ 9,000	$ 9,313	$ 9,225	$111,735
MONTHLY TOTALS	$23,620	$27,174	$22,930	$26,241	$25,685	$29,201	$24,711	$28,136	$27,993	$31,133	$38,173	$37,186	$342,183

*This income is not associated with the ACME Grant. It is an offset to cost incurred by the University for terminal rental, engineering services, and other miscellaneous services provided to the ACME community.

VII. PROJECT DESCRIPTIONS

CORE RESEARCH PROJECT DESCRIPTIONS

Staff

Core research and development projects carried on by the ACME staff during Fiscal 1972 have already been discussed in previous sections of this report.

Principal Investigator

Joshua Lederberg maintains one account for the purpose of system development and testing and another as a utility file for demonstration programs. These projects, PILOT1 and PILOT2, are listed in Category 6 of the Summary of Computer Resource Usage.

Users

During portions of Fiscal 1972, two user projects had core research status: DENDRAL and the Drug Interaction Project. Since both began to be charged for their usage during Fiscal 1972, they are listed below as a combination of core and collaborative research.

CORE AND COLLABORATIVE RESEARCH PROJECT DESCRIPTIONS

Investigator: Edward Feigenbaum, Joshua Lederberg, and Carl Djerassi.
Dept. of Chemistry, Computer Science, and Genetics
Project Began 1970

Project: DENDRAL Realtime
Chargeable use began May 1971

The DENDRAL project involves collaboration between the Instrumentation Research Laboratory operating under NASA grant NGR-05-020-004, investigators operating under NIH grant RR 00612-02, and ACME.

The emphasis of the DENDRAL-ACME efforts is computer science, while that of IRL-ACME endeavors is data acquisition and computer-instrument control.

The DENDRAL project aims at emulating in a computer program the inductive behavior of the scientist in an important but sharply limited area of science: organic chemistry. Most of the work is addressed to the following problem: given the data of the mass spectrum of an unknown compound, infer a workable number of plausible solutions, that is, a small list of candidate molecular structures. In order to complete the task, the DENDRAL program then deduces the mass spectrum predicted by the theory of mass spectrometry for each of the candidates and selects the most productive hypothesis, i.e., the structure whose predicted spectrum most closely matches the data.

Core and Collaborative Research Project Descriptions (cont'd.)

The project has designed, engineered, and demonstrated a computer program that manifests many aspects of human problem solving techniques. It also works faster than human intelligence in solving problems chosen from an appropriately limited domain of types of compounds, as illustrated in the cited publications.

Some of the essential features of the DENDRAL program include:

> Conceptualizing organic chemistry in terms of topological graph theory, i.e., a general theory of ways of combining atoms.
>
> Embodying this approach in an exhaustive HYPOTHESIS GENERATOR. This is a program which is capable, in principle, of "imagining" every conceivable molecular structure.
>
> Organizing the GENERATOR so that it avoids duplication and irrelevancy, and moves from structure to structure in an orderly and predictable way.

The key concept is that induction becomes a process of efficient selection from the domain of all possible structures. Heuristic search and evaluation are used to implement this "efficient selection."

Most of the ingenuity in the program is devoted to heuristic modifications of the GENERATOR. Some of these modifications result in early pruning of unproductive or implausible branches of the search tree. Other modifications require that the program consult the data for cues (pattern analysis) that can be used by the GENERATOR as a plan for a more effective order of priorities during hypothesis generation. The program incorporates a memory of solved sub-problems that can be consulted to look up a result rather than compute it over and over again. The program is aimed at facilitating the entry of new ideas by the chemist when discrepancies are perceived between the actual functioning of the program and his expectation of it.

The DENDRAL research effort has continued to develop along several dimensions during Fiscal 1972. The mass spectra of some previously uninvestigated compounds were recorded. The computer program has been extended to analyze the mass spectra of a more complex class of compounds, using new kinds of data. The artificial intelligence work on theory formation and program generality has also progressed.

Many mass spectra were taken to gather more data for the DENDRAL program. The analysis of the mass spectra of a variety of functional groups provided general mass spectrometry rules for the computer program. The spectra of many estrogenic steroids were taken to elucidate the mass spectrometry of this class of steroids and to provide data for a problem area new to DENDRAL.

The estrogenic steroid problem is new in several respects:

(1) in working with steroids, the program deals with much more complex molecules than ever before;
(2) the computer program uses element maps from high resolution data to resolve ambiguities; and